



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-026

Proposal Title: Off-site Construction Technology Portal

Project Manager Information

Name: Patrick Donahue

Organization: U of MN - Duluth - NRRRI

Office Telephone: (218) 788-2705

Email: pdonahue@d.umn.edu

Project Basic Information

Project Summary: Off-site and digital construction methods can dramatically improve buildings' energy efficiency and reduce construction waste. This project will spearhead creating the skilled workforce required to achieve these improvements in Minnesota.

Funds Requested: \$197,000

Proposed Project Completion: 2023-06-30

LCCMR Funding Category: Small Projects (H)

Secondary Category: Environmental Education (C)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Off-site construction practices are quickly becoming the path to create high-performance, energy/resource efficient, resilient buildings with the least amount of waste. Our intent is to assure that Minnesota is a leader for job creation in off-site built energy efficient homes (single and multi-family) and commercial structures (up to 7 stories) with minimized waste. Across Minnesota, construction technology is currently taught within high schools; technical, community, and tribal colleges; the University of Minnesota and Minnesota State University systems; the State of Minnesota's Department of Labor and Industry (DOLI), and through trade union certified job skills programs. To advance this sector, these educators must have the technical expertise and knowledge based on best practices to develop the skilled workforce and oversight required to create energy- and resource-efficient buildings and systems while keeping housing and commercial properties affordable to build, own, and operate. This project will structure and deliver an integrated strategic initiative to build a team-based best practices portal, develop a curriculum, and execute a train-the-trainer pilot in order to launch a program to advance industrialized off-site, prefabricated, modular construction in Minnesota. This proposal would also solicit input from industry partners to gain their acceptance and support of the program.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

Our proposed solution has three components: creating a web portal, developing specialized curriculum, and executing a train-the-trainer pilot program. These new tools will be provided to construction educators across Minnesota to accelerate the velocity of construction industry transformation from an on-site business model into two off-site models (residential and commercial). Our educational portal will deliver online presence to guide best practices, provide access to global construction sector specialized resources, and deliver educational tools designed for the professional educator. Our curriculum component will provide educators with tools for developing a workforce prepared for the emerging fields of design for manufacturing and assembly (DfMA), off-site construction (prefabrication), and the science of high-performance buildings. Our third element will roll out a pilot program to train the trainers using the new technical skills curriculum in a) principles of DfMA, b) principles of off-site manufacturing, c) approaches to off-site manufacturing, d) energy- and resource-efficient enclosure design practices, e) knowledge of building performance measurement, f) lean design practices in construction management, and g) applications of on-site digital tools. An important element of our delivery is incorporating a diverse advisory board of stakeholders to provide direction and oversight and to assist in linking the work to outcomes.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Best practices, when used in manufacturing off-site/modular buildings, creates a tight-tolerance, optimal platform to properly install efficient materials, detail the insulation, properly seal the enclosure for air and moisture control, install solar panels, provide efficient heating, cooling, and ventilation systems, and configure the building with integrated smart operating systems. Off-site modular manufacturing can achieve a reduction of building carbon footprint by up to 57%, reduce the total number of deliveries by 90%, and result in a 90% waste reduction. At the end of life cycle, these buildings can often be taken apart and recycled dramatically reducing landfill waste.

Activities and Milestones

Activity 1: Off-site Ready Digital Educational Portal

Activity Budget: \$60,000

Activity Description:

Web portals have become vital for both education and industry. Our proposed “Off-site Ready” educational portal will create an online presence to provide access to global off-site construction sector resources, deliver educational tools designed for the professional educator, and guide best construction practices. This portal will serve as an interface between the layers of academic, trade skills development, and industry needs. A robust advisory board will ensure that our online framework aligns with industry needs, including serving underserved Minnesota communities. We will promote the off-site/modular construction industry as a positive career choice for individuals, by retooling the current industry approach to academic engagement and preparation into digital based construction. Our portal will have open public access to extend the benefits beyond internal stakeholders, providing engaged citizens a learning environment to understand the growing importance of utilizing off-site/modular construction to improve energy efficiency and reduce waste. We are committed to fully engaging and collaborating across academia, the trades and industry to support the development and growth of a safer, more sustainable, productive, innovative, growth oriented and profitable construction industry; and ultimately enhance the sector’s relevance and contribution to Minnesota’s environment, job creation, and economy.

Activity Milestones:

Description	Completion Date
Create an advisory board to guide and contribute to the “Off-site Ready” portal	2021-07-31
Develop web page content including guidance on sector-based resources, educational tools, and best construction practices.	2022-02-28
Test portal content with advisory board, a small industry collaborative, and adjust resources, as needed.	2022-05-31
Launch portal and seek continuous improvement using professional social media tools such as LinkedIn	2022-08-31

Activity 2: Creating Curricula for DfMA, Off-site Principles/Approaches, and High-performance Building Design/Metrics

Activity Budget: \$77,000

Activity Description:

The construction and use of buildings accounts for about half of all our extracted materials and energy consumption and about a third of our water consumption. Our curriculum component creates a set of tools for the professional educator supporting the growth of three emerging fields. Our first core curriculum is DfMA, which is revolutionizing construction, making it faster, cleaner, cheaper and more reliable. The result is higher efficiency buildings, less waste in the construction phase, greater efficiency in site logistics, and a reduction in vehicle movements transporting materials to the site. Our second core curriculum is off-site construction principles and approaches. This manifests the DfMA outcomes. We will create curricular materials and tools for teaching off-site/modular construction. Finally, we will provide detailed knowledge in best practices of sustainable energy and resource efficient design, with a focus on the impact of residential and commercial buildings on the environment during the whole building life cycle. Our overarching goal is to improve the knowledge and understanding of high-performance construction techniques and systems that provide significant improvements.

Activity Milestones:

Description	Completion Date
Create Design for Manufacturing and Assembly (DfMA) Interactive Course	2021-09-30
Create Off-site Principles Lectures and Learning Materials	2021-10-31
Create Off-site Manufacturing Approaches Course in Conjunction with Software and Machine Tool Partners	2021-11-30
Create Best Practices of Application High-Performance Buildings for Off-site Methods Course in Conjunction with Industry	2021-12-31
Create Principles of High-Performance Buildings Lectures and Learning Materials	2021-12-31

Activity 3: Online Train-the-trainer pilot program and program launch

Activity Budget: \$60,000

Activity Description:

We will execute a pilot train-the-trainer program in an 8-week program using University of Minnesota online educational tools and the resource development in Activity 2. Each advisory board member will invite 3-4 industry peers to join the pilot program pool. The structure will be one 2-hour class per week, with assignments to lead the group through the web portal resources and to the test curriculum for technology transfer effectiveness. The pilot will include all targeted groups; however, the final delivery of the content will be designed to fit different skill levels. We will collect critical feedback and adjust the delivery as needed. We will then launch the portal as web-based learning tools. Our goal is to create a platform so that all Minnesota-based construction education professionals have access to portal information, tools, and curriculum support, thus creating a curriculum and learning tools that will prepare educational trainers with technical confidence to teach: 1) principles of design for manufacturing assembly, 2) principles of off-site manufacturing, 3) approaches to off-site manufacturing, 4) energy- and resource-efficient enclosure design practices, 5) knowledge of building performance measurement, 6) lean design practices in construction management, and 7) applications of on-site digital tools.

Activity Milestones:

Description	Completion Date
Advisory board invites selected group of peers	2021-11-30
Develop an 8-week training program and curriculum	2022-02-28
Execute pilot train-the-trainer program	2022-05-31
Adjust the curriculum content and restructure for skill-level delivery	2022-06-30
Support program delivery for first year of portal activity	2023-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Garrett Mosiman, Research Fellow, LEED AP	College of Design; Center for Sustainable Building Research	Mosiman will be responsible for curriculum development in performance building metrics, will assist in the delivery of the pilot program and be part of the program launch team.	Yes
Peter Hilger, Faculty Director and Instructor	College of Continuing and Professional Studies; Construction Management	Hilger will be responsible for curriculum development in best practices of construction management (aligning off-site construction and site construction systems), will assist in the delivery of the pilot program and will be part of the program launch team.	Yes
Patrick Huelman, Extension Professor	CFAN Department of Bioproducts and Biosystems Engineering	Huelman will serve as the co-PI. He will be responsible for curriculum development of performance building practices, will assist in the delivery of the pilot program and be part of the program launch team	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

The project will end June 2023. A critical responsibility of our advisory board will be to develop a strategy for statewide adoption of the project's deliverables and to recommend pilot program cohorts. The board will consist of representatives from our state higher education system, school districts, construction companies, MN DOLI, the Minnesota carpentry union trades skills center, and a venture capital firm focusing on legacy industries. The principal investigator has deep expertise and experience in off-site technology deployment and raising awareness and funding from foundations, including the University of Minnesota Foundation's portfolio of philanthropic entities.

Project Manager and Organization Qualifications

Project Manager Name: Patrick Donahue

Job Title: Buildings Products Research Program Manager

Provide description of the project manager's qualifications to manage the proposed project.

Donahue has extensive industrial development and technology transfer experience in the wood-based industrial (OEM) and building materials sectors. This experience includes successful projects in structural framing, engineered wood products, fenestration, wood protection, prefabricated building systems, and exterior cladding. He has the unique skill set to apply best practices in selecting machine tool solutions to fit the material or process technology needs, executing multiple plant installations. His current focus is on building materials research to generate near-term commercial outcomes. This building materials focus is overlain with the goal to find new value streams for Minnesota's timber resources, including implementing new wood residues strategies. The work plan includes niche mass timber products using laminated veneer lumber, niche automated light structural framing products using laminated veneer lumber, new chemical-free modified wood technologies, and engineered wood exterior composite products. Donahue has successfully spun a housing systems technology company out of the University of Minnesota that supports prefabricated housing factories with closed panel designs, machine tool integration, and quality manuals for third-party inspection.

5/14/2020

Over the past 12 months, the business has been engaged in building a new factory in Minnesota that will produce volumetric prefabricated multi-family structures.

Significant past work includes leading a team that generated ready-to-assemble housing system technology, securing funding resources that resulted in two full-scale FEMA demonstration buildings. The same team built a wood modification pilot plant, leading to multiple federally funded research awards from the U.S. Forest Service and National Science Foundation. Donahue developed specialized know-how in the manufacturing of thin-kerf sawing equipment, assisting a northern Minnesota manufacturer to onboard the technology, leading to the creation of a new line of engineered flooring. Lastly, Donahue currently serves on the National Renewable Energy Laboratory –Off-site Construction Advisory Board.

Organization: U of MN - Duluth - NRRI

Organization Description:

As part of the University of Minnesota system research enterprise, NRRI employs over 140 scientists, engineers, technicians, staff and students in two industrial research facilities. Through collaborative partnerships, we deliver the innovative tools and solutions needed to utilize and sustain Minnesota’s precious natural resources. Our integrated portfolio of strategic research groups includes the Materials and Bioeconomy Group. The strategic group’s goal is to increase the economic return from Minnesota's forest harvest by developing value-added products. Expertise and capabilities within this group including building science and systems research, outreach and industrial services. The facility and asset support for this group includes a 6,000-square-foot pilot high bay manufacturing space, an overhead crane, and a large-format carpentry table designed to build advanced panel assemblies. The NRRI has a well-equipped building materials test laboratory that includes capacity to test structural components. In cooperation with the University of Minnesota Duluth’s Civil Engineering Department, the NRRI has access to test full-scale building elements and is in the planning stages to build an exterior materials and fenestration test laboratory. The NRRI has a strong, quality program supporting these laboratories with work instructions.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Patrick Donahue, PI		Donahue will serve as the project PI. He will be responsible for the success of the project, provide leadership to the advisory board, be responsible for two technical curriculum development areas, will organize/lead the delivery of the pilot program, and lead program launch.			26.7%	0.4		\$62,004
Eric Singaas, Project Communications		Singaas will serve as the primary project University liaison. He will provide project updates to parties across the university and will coordinate all external press releases from the NRRI public relations department.			26.7%	0.04		\$7,576
Shima Hosseinpur, Project Management Support		Hosseinpur will provide ongoing project management analysis assuring the project stays on track and stays on budget.			26.7%	0.04		\$4,529
Scott Johnson, Technical Support		Johnson will be responsible to provide training support tools including hands-on video/images, work instructions, and system manual examples.			24.1%	0.4		\$29,719
Jane Reed, Web Design and Support		Reed will be responsible to design the webpage, upload/maintain the online portal presence, and be responsible for adjustments of the webpage structure for the duration of the project.			24.1%	0.08		\$6,188
Patrick Huelman, Co-PI, CFANS/BBE		Huelman will serve as the co-PI. He will be responsible for curriculum development of high performance building practices, will assist in the delivery of the pilot program and be part of the program launch team.			26.7%	0.14		\$27,048
A. Peter Hilger, Key Personnel, CCAPS/CMGT		Hilger will be responsible for curriculum development in best practices of construction management (aligning off-site construction and on site construction systems), will assist in the delivery of the pilot program and be part of the program launch team.			26.7%	0.2		\$22,481

Garrett Mosiman, Key Personnel, COD/CSBR		Mosiman will be responsible for curriculum development in high performance building metrics, will assist in the delivery of the pilot program and be part of the program launch team.			26.7%	0.26		\$30,855
							Sub Total	\$190,400
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
							Sub Total	-
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$180 for mileage, \$157 for lodging, and \$114 for per diem expenses.	All travel has a similar intent - to meet with the co-PI and other key personnel who are all located at the University of Minnesota twin Cities campuses. This will be our first organizational meeting.					\$451
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$180 for mileage, \$157 for lodging, and \$114 for per diem expenses.	This will be our first quarterly face-to-face meetings. We will discuss project feedback from the advisory board, discuss project activity and milestones in detail, and review project budget status.					\$451
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$193 for mileage, \$157 for lodging, and \$114 for per diem expenses. Adjusted for inflation year 2.	This will be our second quarterly face-to-face meetings. We will discuss project feedback from the advisory board, discuss project					\$464

			activity and milestones in detail, and review project budget status. We will make any project adjustments needed.					
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$180 for mileage, \$157 for lodging, and \$114 for per diem expenses.	This will be our yea review meeting. We will invite the advisory board to this meeting. will review all curriculum content and adjust of pilot program delivery.					\$451
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$193 for mileage, \$157 for lodging, and \$114 for per diem expenses. Adjusted for inflation - year 2.	This will be our first quarterly meeting of year 2. We will discuss the delivery of our pilot program and make adjustments as needed.					\$464
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$180 for mileage, \$157 for lodging, and \$114 for per diem expenses.	This will be our second quarterly meeting of year 2. We will discuss the results of our pilot program and refine the content for your program launch.					\$451
	Miles/ Meals/ Lodging	This is a single overnight trip from Duluth to Minneapolis. This travel includes \$194 for mileage, \$157 for lodging, and \$114 for per diem expenses. Adjusted for inflation - year 2.	This will be our final project meeting. We will invite the advisory board to this meeting. We will review project outcomes and prepare if final report.					\$465
							Sub Total	\$3,197
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Printing	Printed Support Documents and Reference Materials, an estimated quantity of 40, at an estimated cost of \$85.08 each	To provide printed materials to the project team, the advisory board, and pilot program participants. The hard copies will include all base line reference material in order to streamline the delivery of the online elements of the portal					\$3,403
							Sub Total	\$3,403
Other Expenses								

							Sub Total	-
							Grand Total	\$197,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	\$108,350
			Non State Sub Total	\$108,350
			Funds Total	\$108,350

Attachments

Required Attachments

Visual Component

File: [521d77a4-8b6.pdf](#)

Alternate Text for Visual Component

The graphic is a diagram showing the University of Minnesota project team and the Advisory Board collaborating to produce the Off-Site Construction Technology Education Portal. The diagram shows the portal being applicable to the Target Audience, which includes high schools, technical colleges, union training programs and industry. There are two background images showing a modular building component being lifted by a crane, and panelized building components in a factory. attachment in progress

Optional Attachments

Support Letter or Other

Title	File
Letter of Support 3M	7508af8e-dbb.pdf
Letter of Support ADL Ventures	21c8b9e5-f2e.pdf
Letter of Support Kraus-Anderson	2923221e-d66.pdf
Letter of Support Rise Modular	f713b2c8-26f.pdf
Letter of Support LP Building Materials	efd2af48-229.pdf
Letter of support Washington State University	144a919d-103.pdf
Sponsored Projects Transmittal Letter	29ccb923-49c.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

UMN Project Team

UMD/ NRRI

CFANS/BBE

CCAPS/CMGT

CDes/CSBR

Advisory Board

High School Educator

Community College Educator

U of MN Tribal Liason

Industry Educator

Trade Union Educator

Dept. of Labor and Industry

Off-site Construction Technology Educational Portal

Target Audience

High Schools

State, Community, Technical
Colleges

Union Trades Training
Programs

Industry

Builders Developers

Manufacturers